Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

F-Praktikum Review Day

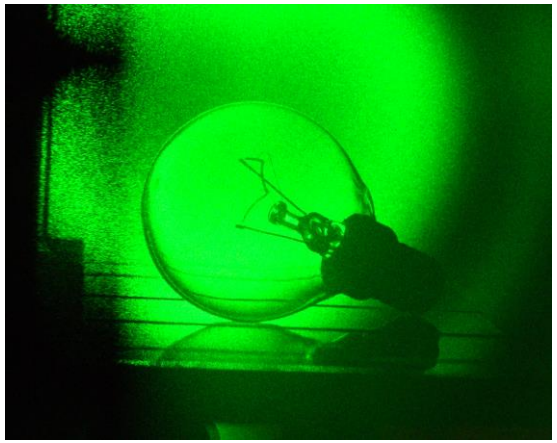
EXP 14 Holography

General aspects

- The topic of holography is not at the forefront of current research but deals with many basic aspects of optical physics, among them are
  - Lasers
  - geometrical optics: imaging
  - interference – coherence
  - Fourier optics
  - Light-matter interaction: diffraction, refraction
- some of the topics are part of Physics II-IV but not all are dicussed in the lectures
- the experiment is carried out in typically three full days at site, protocol length (20-30 pages)

Aim of the experiment

- Setup a full optical experiments from scratch
- Learn to align and use optical elements, detectors, etc:
  → develop (optical) alignment strategies and experimental skills in general
- Understand the concepts of
  - Fourier optics
  - Interference/coherence
  - Holography
- Produce high-quality holograms with rather simple means (the fun part).



Aim of the experiment

- As typically many students come with a lack of understanding the underlying physical principles, additional „pre-experiments“ were added:

  1.) Michelson-Interferometer:

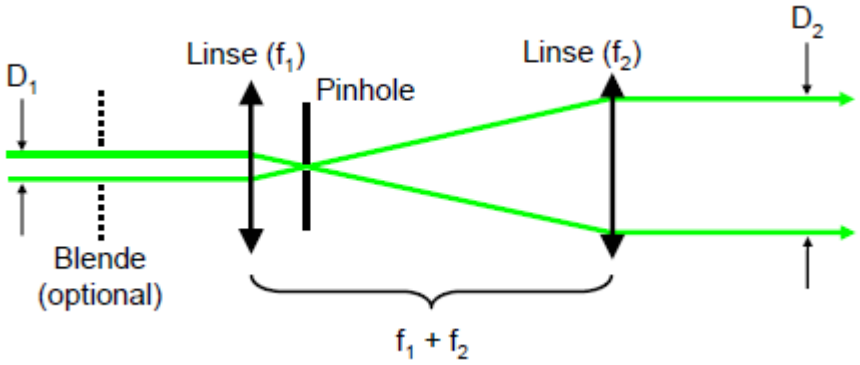
  → basics of interferometry&coherence

  → interfereometry as versatile tool for precise measuring coherence length, refractive index of a gas, etc.

  2.) spatial filter

  → concept of Fourier optics

  → setting up laser telescopes



Experimental Setup

- The students start with an empty optical table and a cupboard full of optical and opto-mechanical pieces.
- For each sub-task they need to understand the goal, discuss the required setup and realize it on the optical table accordingly.
- Challenges:
  - The majority comes with very few experimental experience (not only in optics).

    → Even aligning a lens properly can be a difficult task.

    → Interferometric setups require precise alignments and therefore sometimes patience.

    → Before a hologram can be succesfully recorded a lot of single parameters have to be adjusted in the right way („Everything needs to work at the same time“).

Data analysis methods

- Apart from the pre-experiments there is no data taken.
- Evaluation of the „main“ results is done on the the fly, i.e. reconstruction of holograms and judge the quality → define measures for further improvement.
- Pre-experiments:
  - Measured data:
    → CCD camera images, software based evaluation (ImageJ) on acquired intensities etc.
    → additional data taken by hand: length measurement, fringe counting, ...
  - Simple data avaluation, compute mean values+errors, error propagation.
  - Apply a curve fit to some data.

Key scientific results/relevance/link to modern research

- **As stated above: emphasis is more on teaching general concepts and aspects of optical physics:**

  → basis for work in optical or laser labs

- **Grading according to scheme:**

Theory / preparation	Setup / experimental	Data taking	Analysis	Protocol
2-3	2	4	3-4	3

Key scientific results/relevance/link to modern research

- Links to current research:
  - All labs using optical techniques.
  - Experiments using holographic techniques (Petra, Flash, XFEL).
  - Experiments using lensless imaging techniques.
  - Most likely more...

→ Questions?